

Orchid diversity in a logging concession in Tabalong District, South Kalimantan, Indonesia

DWI MURTI PUSPITANINGTYAS*

Center for Plant Conservation and Botanic Gardens (Bogor Botanic Gardens), Indonesian Institute of Sciences. Jl. Ir. H. Juanda No. 13, Bogor 16122, West Java, Indonesia. Tel. +62-251-8322187. Fax. +62-251-8322187, *email: puspitakrb@yahoo.com

Manuscript received: 3 July 2020. Revision accepted: 28 October 2020.

Abstract. Puspitaningtyas DM. 2020. *Orchid diversity in a logging concession in Tabalong District, South Kalimantan, Indonesia. Biodiversitas 21: 5455-5464.* Borneo is the third largest island in the world, and considered the "island of orchids" since it has approximately 2.500-3.000 species of orchids, equivalent to 10% of the orchids in the world. The aim of the research was to study orchid diversity in a logging concession in the village of Dambung Raya, Ara Bintang Sub-district, Tabalong District, South Kalimantan Province, Indonesia. This research also collected living specimens of orchid to be grown in Bogor Botanic Gardens, West Java, Indonesia, and Banua Botanic Gardens, Banjarbaru, South Kalimantan, Indonesia. The orchid inventory was carried out using explorative method. The study recorded 64 species of epiphyte orchids and one species of terrestrial orchid, altogether belong to 27 genera. Some interesting orchid species found in this area included *Acriopsis* spp., *Aerides odorata* Lour, *Coelogyne* spp. (*C. motleyi* Rolfe ex J.J.Wood, D.A.Clayton & C.L.Chan, *C. foerstermannii* Rchb.f., *C. rochussenii* de Vriese, *C. pandurata* Lindl.), *Grammatophyllum speciosum* Blume, *Liparis* spp., *Pteroceras teres* (Blume) Holttum, *Thrixspermum raciborskii* J.J.Sm. subsp. *brevipollinium* P. O'Byrne & A. Ent., and *Thecostele alata* (Roxb.) EC Parish & Rchb.f. Orchid endemic to Borneo found in this area were *Coelogyne motleyi* Rolfe ex JJ Wood, DA Clayton & CL Chan, *Cleisostoma brachystachys* (Ridl.) Garay and *Thrixspermum raciborskii* J.J.Sm. subsp. *brevipollinium* P. O'Byrne & A. Ent.

Keywords: Inventory, orchid, South Kalimantan, Tabalong

INTRODUCTION

Borneo is the third largest island in the world. The island is known as the center of biological diversity (Whitmore 1984). According to van Steenis (1971), Borneo has 25,000 species of flowering plants or 10% of all flora in the world. Ashton (1982) explains that there are approximately 3000 species of trees, including 267 species of Dipterocarpaceae grow on Borneo in which 58% of them are endemic species. Borneo also has a high level of orchid diversity with 2500-3000 species of orchid species described from the island, or equivalent to 10% of the total number of orchids in the world (Whitmore 1984; Lamb 1991). Of these 30-40% of the species are endemic orchids to Borneo. As such, Borneo is often considered as "orchid island" (Chan et al. 1994).

The floristic diversity in Borneo, including orchid, is the mix of floristic elements from Australia and Asia land, making it is very rich in diversity (Chan et al. 1994). Besides this biogeographical mixture of two continents, the high diversity of plant species in Borneo is closely related to several factors including topography, altitude, geology, soil type, climate, and ecosystem diversity (MacKinnon et al. 1996). Borneo has various types of forest ecosystems such as mangrove forests, peat forests, peat swamp forests, kerangas forests, lowland forests, limestone forests, mountain forests, and coastal forests.

The diversity of orchid species generally increases with altitude in Dipterocarps forest (Chan et al. 1994). Most

species of orchids prefer to grow in mountainous forests between 500 m and 1500 m above sea level (Comber 1990). However, other habitats in Borneo such as the mangroves can be much poorer in orchid species. Very poor information of the orchid flora of the mangrove forests due to the difficulty of walking through them.

Many Asian orchids are threatened with extinction because of over-collection and habitat destruction (Park et al. 2000). The major causes of plant endangerment in Indonesia are biological factors, habitat loss, over-exploitation, and natural factors. For orchids, biological factors, habitat loss, and over-exploitation for economic purposes are the most important factors that threaten orchids in Indonesia (Budiharta et al. 2011). Orchid species are the most highly threatened species, compared to other threatened species of Indonesia. There are about 203 species (39% of threatened species of Indonesia) (WCMC 1995).

Borneo's orchids are also at an alarming rate, due to loss of natural habitat caused by fires, forest destruction, and illegal logging. Increased exploitation of the forests, especially in West Borneo, including gold mining, forest fires, and illegal burning, has led to the extinction of hundreds of orchid species. Economic factors, including illegal collecting and selling of wild orchids by collectors (orchid lovers), along with increasing consumer demand for orchids, also contribute to the endangerment of Borneo's native orchids (Siregar 2008).

Only half of Borneo's forest cover remains today, down from 75% in the mid-1980s. With a current deforestation

rate of 1.3 million hectares per year, only peat and montane forests would survive in the coming years (WWF 2020). In 2001, South Kalimantan had 722 kha of primary forest, extending over 19% of its land area. In 2019, it lost 4.12kha of primary forest (Global Forest Watch 2020).

Recently Indonesian orchids have been included as a part of the Malesian flora subject to be investigated. J.B. Comber from England has published *Orchids of Java* (1990) and *Orchid of Sumatra* (2001) which are very important contributions to the flora of the most highly populated island in Indonesia. Currently there are many authors from abroad who publish Indonesian orchid species richness. The first volume of *Orchids of Borneo* has been published as part of the estimated 20 volumes to be written by the Kew & Leiden group, such as: *Orchids of Borneo Vol. I* (Chan et al., 1994), *Orchids of Borneo Vol. II* (Vermeulen, 1991), *Orchids of Borneo Vol. III* (Wood, 1997), *Orchids of Borneo Vol. IV* (Wood 2003), *Dendrobium of Borneo* (Wood 2013).

Botanical exploration and research are important efforts in plant conservation, both *in situ* and *ex-situ*. Moreover, the exploration could take place in threatened landscapes, such as logging concession and mining concession, so that information related to botanical diversity in such landscapes can be collected before it is lost. Despite collecting data, botanical exploration would be more beneficial if this activity could also collect living plant specimens to be collected in *ex-situ* conservation areas such as botanical gardens and arboretum. Furthermore, gathering information on native Bornean orchids was stimulated by the large variety of species found in Borneo, and also the lack of literature and specimen references available in South Kalimantan. The aim of the research was to study orchid diversity in a logging concession in Tabalong District, South Kalimantan Province, Indonesia. In logging areas, there is a high risk of declining orchid populations or even loss of orchid species in its natural habitat. This research also collected living specimens of orchid to be grown in Bogor Botanic Gardens, West Java,

Indonesia, and Banua Botanic Gardens, Banjarbaru, South Kalimantan, Indonesia. *Ex-situ* conservation of living orchids in Botanic Gardens is very urgent to be done to save orchid species from extinction in nature.

MATERIALS AND METHODS

Study area and period

The study was conducted in the area of a logging concession located in the village of Dambung Raya, Bintang Ara Sub-district, Tabalong District, South Kalimantan Province, Indonesia. The concession managed forest area of 87,241 hectares. The study site was located between S 01°40'10.9"-E 115°29'09.1" and S 01°42'41.7"-E 115°26'08.8". The exploration was conducted between 22 October-20 November 2013. The topography of the forest area is a hilly mountain with steep slopes from 0-40%, altitude between 200-600 m. The soil consists of sandstone, limestone, rock and limestone, clay yellowish-white, Red Yellow Podsol, Red Yellow Podsol, Latosol complex, and Litosol. Its forests are dominated by species of Dipterocarpaceae family (Imanuddin and Wahjono 2007).

Data collection

The study was conducted using explorative methods (Hidayat et al. 2017; Partomihardjo and Rahajoe 2004). The living materials of orchid was identified into species level based on the morphological characteristics, in particular the flower. For specimen not in flowering stage, an initial identification was made to genus level then the living material was brought to Bogor Botanic Gardens and Banua Botanic Gardens for *ex situ* conservation. Plant samples were taken and collected only 1-5 specimens for species that are abundant in the field. Then to support *in situ* conservation, species that rarely found were not taken sample and were only recorded or photographed for documentation. Whenever the flower was appearing, further identification was conducted.

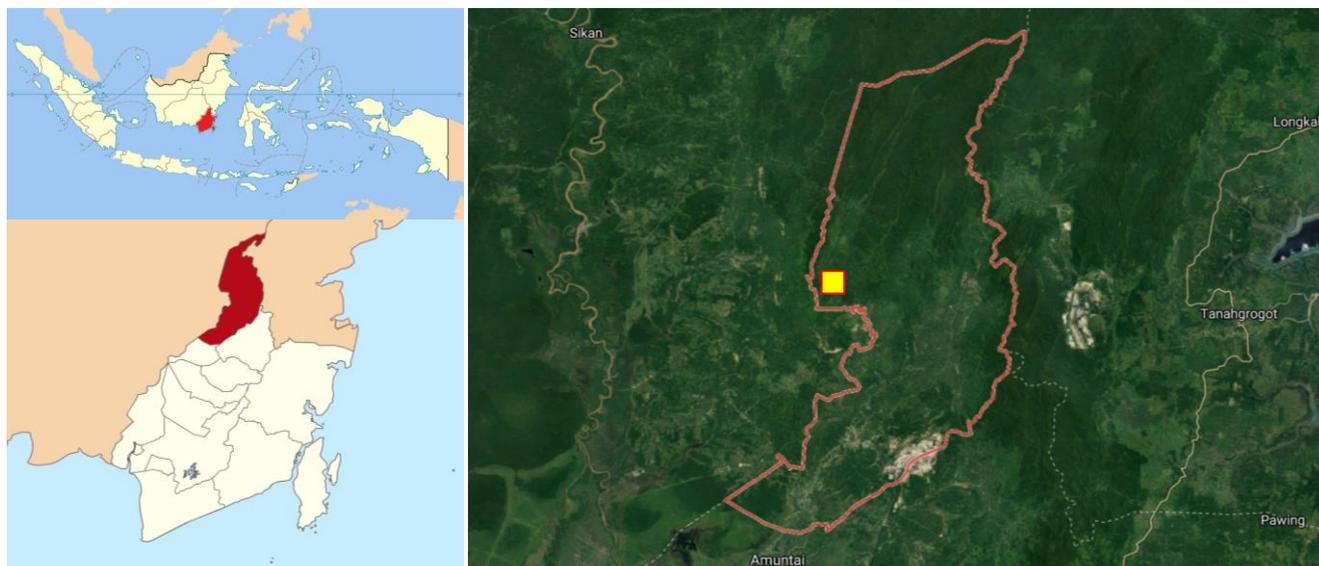


Figure 1. Map of the study site in Dambung Raya Village (■), Tabalong District, South Kalimantan Province, Indonesia

Identification to species level referred to living collections in the Bogor Botanic Gardens as well as literature review (Comber 1990, 2001; Vermeulen 1991; Seidenfaden and Wood 1992; Chan et al. 1994; Wood and Cribb 1994; Wood 1997, 2001, 2003, 2013; Gravendeel 2000). Valid name was updated based on the database of The Plant List (2013).

RESULTS AND DISCUSSION

The forest area of the logging concession an altitude between 200 and 600 meters above sea level (m asl). The topography in the study site was a hilly mountain with steep slopes from 0-40%. The soil consists of sandstone, limestone, rock and limestone, clay yellowish-white, red yellow Podsol, red yellow Podsol, red yellow Podsol complex, and Litosol. The vegetation was dominated by species of Dipterocarpaceae family (Imanuddin and Wahjono 2007). Some dominant species were Tengkawang (*Shorea stenoptera* Burck), Jelutung (*Dyera costulata* (Miq.) Hook.f.), Artocarpus spp., Bangkirai (*Shorea laevis* Ridl.), Kapur (*Dryobalanops* spp.), Dungun (*Syzygium* sp.), Meranti (*Shorea* spp.), Nyatoh (*Palaquium* sp.), Kuranji (*Dialium* sp.), Madang (*Litsea* sp.), Binuang (*Octomeles sumatrana* Miq.) and Sindur (*Sindora* sp.) (Panjaitan et al. 2013). The study was carried out at an altitude between 200 and 326 (m asl). It had soil pH of 6.2-6.7 and air humidity (RH) of 54-72%. The habitat can be described as secondary forest. The study recorded 65 orchid species belonging to 27 genera in which 64 were epiphytic orchids and one species was terrestrial orchid (Table 1). Recently, some genera have changed to new names. Genera *Diplocaulobium* and *Flickingeria* are reincluding in genus *Dendrobium*; some species of *Eria* are split into

Campanulorchis, *Mycaranthes*, and *Pinalia*. Details of the species found along with their habitus are presented in Table 1. The highest number of species found in this area was *Dendrobium* then followed by *Bulbophyllum* and *Coelogyne*. This data is shown in Figure 2.

Some interesting orchids with beautiful flowers recorded in the study location were *Aerides odorata* Lour, *Acriopsis* spp. (*A. liliifolia* (J.Koenig) Seidenf. and *A. ridleyi* Hook.f.), *Coelogyne* spp. (*C. motleyi* Rolfe ex J.J.Wood, D.A.Clayton & C.L.Chan, *C. foerstermannii* Rchb.f., *C. rochussenii* de Vriese, *C. aff. pandurata* Lindl.), *Grammatophyllum speciosum* Blume, *Liparis* spp. (*Liparis latifolia* Lindl. and *Liparis parviflora* (Blume) Lindl., *Pteroceras teres* (Blume) Holttum, *Thecostele alata* (Roxb.) E.C.Parish & Rchb.f., and *Thrixspernum arachnites* (Blume) Rchb.f. (Figure 2). Two species endemic to Borneo found in this area were *Coelogyne motleyi* Rolfe ex J.J.Wood, D.A.Clayton & C.L.Chan. and *Cleisostoma brachystachys* (Ridl.) Garay.

Notes on the species found in the study location

Adenoncos parviflora Ridl.

There are six species of *Adenoncos* recorded in Borneo, which are *Adenoncos sumatrana* J.J.Sm., *A. major* Ridl., *A. parviflora* Ridl., *A. buruensis* J.J.Sm., *A. triloba* Carr, *A. virens* Blume. The species found in this area were identified as *A. parviflora* Ridl. This species is an epiphyte orchid and was found attached to a rotten tree trunk. The stem is erect to pendant, with a basally branching stem enveloped completely by leaf. It has thick fleshy leaves, linear, acute, and basally clasping leaves. It has 1-4 flowers in a cluster at each node all in a close row. It grows in the lowlands of mixed dipterocarp at an altitude of 270-340 m.

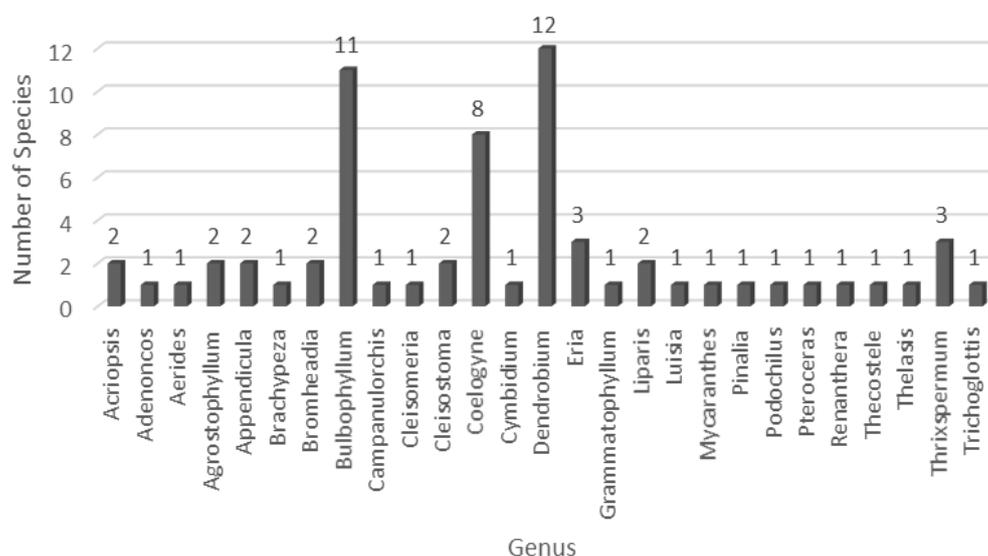


Figure 2. Number of orchid species for each genus found in logging concession in Dambung Raya Village, South Kalimantan Province, Indonesia

Table 1. Orchid diversity in a logging concession in Dambung Raya village, Tabalong District, South Kalimantan, Indonesia

Name of orchid	Habitus
<i>Acriopsis</i> aff. <i>ridleyi</i> Hook.f.	Epiphyte
<i>Acriopsis liliifolia</i> (J.Koenig) Seidenf.	Epiphyte
<i>Adenoccos parviflora</i> Ridl.	Epiphyte
<i>Aerides odorata</i> Lour.	Epiphyte
<i>Agrostophyllum elongatum</i> (Ridl.) Schuit.	Epiphyte
<i>Agrostophyllum stipulatum</i> (Griff.) Schltr.	Epiphyte
<i>Appendicula cornuta</i> Blume	Epiphyte
<i>Appendicula undulata</i> Blume	Epiphyte
<i>Brachypeza indusiata</i> (Rchb.f.) Garay	Epiphyte
<i>Bromheadia aporoides</i> Rchb.f.	Epiphyte
<i>Bromheadia finlaysoniana</i> (Lindl.) Miq.	Terrestrial
<i>Bulbophyllum</i> aff. <i>acuminatum</i> (Ridl.) Ridl.	Epiphyte
<i>Bulbophyllum</i> aff. <i>cornutum</i> (Blume) Rchb.f.-DM 2728	Epiphyte
<i>Bulbophyllum</i> aff. <i>dearei</i> (Rchb.f.) Rchb.f.	Epiphyte
<i>Bulbophyllum</i> aff. <i>flabellum-veneris</i> (J.Koenig) Aver.	Epiphyte
<i>Bulbophyllum binnendijkii</i> J.J.Sm.	Epiphyte
<i>Bulbophyllum odoratum</i> (Blume) Lindl.	Epiphyte
<i>Bulbophyllum penduliscapum</i> J.J.Sm.	Epiphyte
<i>Bulbophyllum purpurascens</i> Teijsm. & Binn.	Epiphyte
<i>Bulbophyllum</i> sp.-DM 2712	Epiphyte
<i>Bulbophyllum</i> sp.-DM 2734	Epiphyte
<i>Bulbophyllum vaginatum</i> (Lindl.) Rchb.f.	Epiphyte
<i>Campanulorchis leiophylla</i> (Lindl.) Y.P.Ng & P.J.Cribb)	Epiphyte
<i>Cleisomeria lanatum</i> (Lindl.) Lindl. ex G.Don	Epiphyte
<i>Cleisostoma brachystachys</i> (Ridl.) Garay	Epiphyte
<i>Cleisostoma suaveolens</i> Blume	Epiphyte
<i>Coelogyne</i> aff. <i>pandurata</i> Lindl.	Epiphyte
<i>Coelogyne</i> aff. <i>septemcostata</i> J.J.Sm.	Epiphyte
<i>Coelogyne</i> aff. <i>swaniana</i> Rolfe	Epiphyte
<i>Coelogyne asperata</i> Lindl.	Epiphyte
<i>Coelogyne foerstermannii</i> Rchb.f.	Epiphyte
<i>Coelogyne motleyi</i> Rolfe ex J.J.Wood, D.A.Clayton & C.L.Chan	Epiphyte
<i>Coelogyne pulverula</i> Teijsm. & Binn.	Epiphyte
<i>Coelogyne rochussenii</i> de Vriese	Epiphyte
<i>Cymbidium</i> aff. <i>finlaysonianum</i> Lindl.	Epiphyte
<i>Dendrobium acaesum</i> Lindl.	Epiphyte
<i>Dendrobium bancanum</i> J.J.Sm	Epiphyte
<i>Dendrobium brevicolle</i> J.J.Sm.	Epiphyte
<i>Dendrobium capituliflorum</i> Rolfe	Epiphyte
<i>Dendrobium grande</i> Hook.f.	Epiphyte
<i>Dendrobium lampongense</i> J.J.Sm. .	Epiphyte
<i>Dendrobium lobulatum</i> Rolfe ex J.J.Sm.	Epiphyte
<i>Dendrobium plicatile</i> Lindl.	Epiphyte
<i>Dendrobium</i> sp. DM 2717	Epiphyte
<i>Dendrobium</i> sp. DM 2738	Epiphyte
<i>Dendrobium</i> sp. DM 2739	Epiphyte
<i>Dendrobium truncatum</i> Lindl.	Epiphyte
<i>Eria nutans</i> Lindl.	Epiphyte
<i>Eria</i> sp. DM 2748	Epiphyte
<i>Grammatophyllum speciosum</i> Blume	Epiphyte
<i>Liparis latifolia</i> Lindl.	Epiphyte
<i>Liparis parviflora</i> (Blume) Lindl.	Epiphyte
<i>Luisia</i> sp. DM 2692	Epiphyte
<i>Mycaranthes pannea</i> (Lindl.) S.C.Chen & J.J.Wood)	Epiphyte
<i>Pinalia floribunda</i> (Lindl.) Kuntze	Epiphyte
<i>Pinalia recurvata</i> (Hook.f.) Kuntze	Epiphyte
<i>Podochilus densiflorus</i> Blume	Epiphyte
<i>Pteroceras teres</i> (Blume) Holttum	Epiphyte
<i>Renanthera</i> sp. DM 2715	Epiphyte

<i>Thecostele alata</i> (Roxb.) E.C.Parish & Rchb.f.	Epiphyte
<i>Thelasis carinata</i> Blume	Epiphyte
<i>Thrixspermum raciborskii</i> J.J.Sm. subsp.	Epiphyte
<i>brevipollinium</i> P. O'Byrne & A. Ent	
<i>Thrixspermum scopa</i> (Rchb.f. ex Hook.f.) Holttum	Epiphyte
<i>Thrixspermum</i> sp.-DM 2726	Epiphyte
<i>Trichoglottis geminata</i> (Teijsm. & Binn.) J.J.Sm.	Epiphyte

Acriopsis spp.

Genus *Acriopsis* is an epiphyte orchid which consists of only 6 species in the world, spread from Sikkim, Assam (India), the Solomon Islands, Southeast Asia, Papua New Guinea to Australia (Comber 1990). It grows well in the lowlands to the mountainous areas (0-1.000 m). These two species were found in this area, namely *Acriopsis* aff. *ridleyi* Hook.f. and *Acriopsis liliifolia* (Koen.) Ormerod. They were found in lowland secondary forest at an altitude of 231-326 m. They are both very easy to distinguish, *A. ridleyi* has unbranched inflorescence (O'Byrne 2011) and *A. liliifolia* has long branching inflorescence (Comber 1990).

Aerides odorata Lour.

This species is common found in lowland area below 500 m asl (Comber 1990). In this area, it was found at 326 m asl. It is widely distributed from India to over most of South-East Asia. This species can be distinguished from others by the fragrant flowers. It is a monopodial epiphyte orchid with strap-shaped leaves places in two rows. Leaves tough and thick, with bilobed apex. Inflorescence axillar, the peduncle supports 20-30 flowers. Flowers are white with or without pink-purple spotting and blotching, fragrant. Lips trilobed and spurred, spur curved forward like a nail with a pointy tip.

Agrostophyllum spp.

There were two species of *Agrostophyllum* found in this study namely *Agrostophyllum stipulatum* (Griff.) Schltr. and *Agrostophyllum elongatum* (Ridl.) Schuit. Only *Agrostophyllum stipulatum* (Griff.) Schltr., which was formerly known as *Agrostophyllum bicuspidatum* J.J.Sm., can be easily distinguished from other species. It has a single or two flowers. Both were found at 200 m asl.

The *Agrostophyllum* genus is not very exciting orchids, because the flowers are small and usually whitish or yellowish, globular heads of many flowers, and dry by the time the flowers open. The center of distribution of this genus is mostly in tropical countries, and in Borneo there are 15 species (Comber 1990). *A. stipulatum* commonly grows at an altitude of 200-1,400 m asl. and often forming large clumps. This orchid is widespread in Southeast Asia to the Salomon Islands (Comber 1990). While *A. elongatum* which is formerly known as *Appendicula elongata* Ridl. commonly grows in lowland forest in shaded positions at an altitude of 90-1,000 m asl. and can be found on tree branches in secondary rainforest with humus and moss. This species is widespread in Malesia (Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, Moluccas, New Guinea, The Philippines, Solomon Islands, Vanuatu, Carolines (O'Byrne 1994).

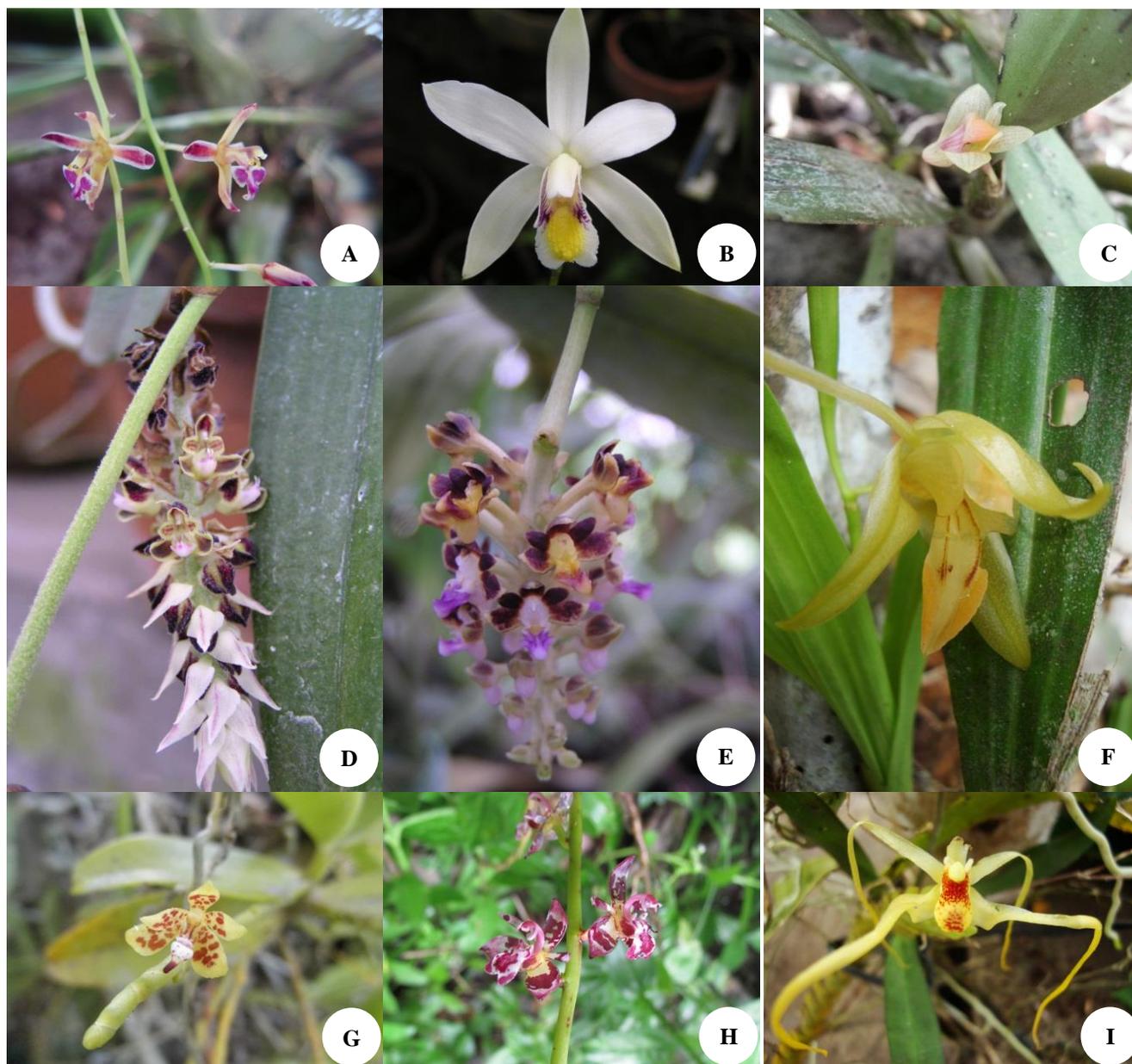


Figure 3. Orchids in Dambung Raya village, Bintang Ara Sub-district, Tabalong District, South Kalimantan, Indonesia. A. *Acriopsis liliifolia* (J.Koenig) Seidenf.; B. *Bromheadia finlaysoniana* (Lindl.) Miq.; C. *Dendrobium bancanum* J.J.Sm; D. *Cleisomeria lanatum* (Lindl.) Lindl. ex G.Don; E. *Cleisostoma* aff. *brachystachys* (Ridl.) Garay; F. *Coelogyne motleyi* Rolfe ex J.J.Wood, D.A.Clayton & C.L.Chan; G. *Pteroceras teres* (Blume) Holttum; H. *Thecostele alata* (Roxb.) E.C.Parish & Rchb.f.; I. *Thrixspermum raciborskii* J.J.Sm. subsp. *brevipollinium* P. O'Byrne & A. Ent

Appendicula spp.

There were two species of *Appendicula* found in this study: *Appendicula cornuta* Blume and *Appendicula undulata* Blume. These orchids are sympodial plants without pseudobulb. Epiphytes on the stem host plant, leaves placed in two rows. Inflorescence of *A. cornuta* is terminal, and *A. undulata* has both terminal and lateral inflorescences.

Appendicula cornuta is widely distributed from China, Hong Kong, Assam, Himalayan, Myanmar, Thailand, Cambodia, Vietnam, Malaysia, Philippines, Sumatra, Borneo, Java, Celebes (Sulawesi). Growing in damp forest

at an altitude of 500-1,500 m. While *Appendicula undulata* is found in Peninsular Malaysia, Sumatra, Java, and Borneo, at an altitude of 400-1,000 m. (Comber 1990). In this area, *A. cornuta* was found at range of 200-326 m altitude, while *A. undulata* was found on tree branches in secondary rainforest at 251 m above sea level.

Brachypeza indusiata (Rchb.f.) Garay

Brachypeza indusiata (Rchb.f.) Garay is a monopodial epiphyte orchid with short stem which is covered by alternate leaves. The leaves are oval-shaped and widened at the ends, thick and fleshy, 25 cm long and 5.5 cm wide,

green. Inflorescence arising from a lower axil, pendulous or bent downwards, densely many-flowered, 24-30 cm long. Inflorescences are 8 cm long with thick rachis and carry very dense flowers with a short life. Flowers are pale yellow with a few transverse brown streaks. (Seidenfaden and Wood 1992; Wood 2003).

It grows in lowland forest to hill forest at elevations of 5 to 300 meters asl. in shaded positions. It is widely distributed in Malesia (Peninsular Malaysia, Sumatra, Borneo, Sulawesi, Moluccas, New Guinea) (Seidenfaden and Wood 1992; Wood 2003). In this study area, it was found attached to the main stem in secondary forest at an altitude of 200 m asl.

Bromheadia spp.

There were two species of *Bromheadia* in the study location, namely *Bromheadia finlaysoniana* (Lindl.) Miq. and *Bromheadia aporoides* Rchb.f. The terrestrial orchid of *B. finlaysoniana* is growing in a clump with close-set stem, 1-1.5 m high with stiff leaves, rarely branching. The flowers white and yellow interiors with mauve to pink-purple exteriors, 5-6 cm in diameter. This species has a wide distribution that includes Thailand, Laos, Cambodia, Vietnam, Malaysia, Sumatra, Borneo, Moluccas, New Guinea, and the Philippines in open scrub and light montane forests at elevations of 50-1,500 m asl. (Seidenfaden and Wood 1992; Kruizinga 1997; Wood and Cribb 1994). In this study area, it was found in an open area at an altitude of 251 m with 70% air humidity and soil acidity was around 6.7.

Bromheadia aporoides is an epiphyte with leafy cane-like, leafy stems. Leaves are distichous, acute, clasping basal leaf sheaths. Inflorescence supports 1 to 3 flowers in opposite ranks, 2 cm cross, only a few flowers open at a time. Found in Myanmar, Thailand, Malaysia, Laos, and Borneo at elevations around 300-1,600 m asl. in hill and montane forests as a miniature sized (Seidenfaden and Wood 1992; Kruizinga 1997). In this study area, it was found on tree branches in secondary forest at an altitude of 286 m asl.

Bulbophyllum spp.

There were eleven species of *Bulbophyllum* found in this area. These orchids are mostly epiphyte with creeping rhizomes, sympodial with pseudobulbs placed at varying intervals on the rhizome. But not much in flowering time, so they have not been identified precisely to species. There are several species of flowering after being planted in the botanical garden so some of them can be identified as species such as *Bulbophyllum* aff. *acuminatum* (Ridl.) Ridl., *Bulbophyllum binnendijkii* J.J. Sm., *Bulbophyllum* aff. *flabellum-veneris* (J.Koenig) Aver., *Bulbophyllum* aff. *dearei* (Rchb.f.) Rchb.f., *Bulbophyllum* aff. *cornutum* (Blume) Rchb.f., *Bulbophyllum penduliscapum* J.J.Sm., *Bulbophyllum purpurascens* Teijsm. & Binn., *Bulbophyllum odoratum* (Blume) Lindl. and *Bulbophyllum vaginatum* (Lindl.) Rchb.f. According to Comber (1990), *Bulbophyllum binnendijkii* J.J. Sm. is a Javanese endemic orchid. However, Puspitaningtyas (2009) has found in Central Kalimantan as a new record after the flower

blooming, the plant can be identified as *B. binnendijkii*. However, other *Bulbophyllum* cannot be identified without flowering specimens, because there are many species with the same morphology of leaf and bulb. Identifying species names can not only be seen from the morphological structure of the plant, but also from the structure of the flowers.

Campanulorchis leiophylla (Lindl.) Y.P.Ng & P.J.Cribb

It was previously placed in the genus *Eria* namely *E. leiophylla* Lindl. These epiphytic orchids are growing sympodial. Rhizome rather stout, the erect shoots about 2-6 cm apart. Sheaths of growing shoots are covered with red-brown woolly hairs. Pseudobulbs are ovoid, narrowed to the end, 4.5-9 cm long, and 1-2 cm thick at the base, supports 2 leaves at the top. Leaves are elliptic-oblong, 15-18 cm long, and 1.7-2.5 cm wide. This genus is very easy to identify because after the flower stalk falls, it will leave a hole mark at the bulb stem. It is distributed in Peninsular Malaysia, Borneo, Sumatra, Sulawesi, and Moluccas (Maluku). It is common found on lowland limestone hills, peat swamp forests, and lower montane forests from sea level to 2000 meters altitude. Exposed situations are preferred, such as high tree branches or on the crowns of trees (O'Byrne 2001). In this study area, it was found on tree branches in secondary forest at an altitude of 251 m.

Cleisomeria lanatum (Lindl.) Lindl. ex G. Don

A genus of two species, recognized by the dense many-flowered often branching inflorescence with floral bracts that much longer than the leaves. This epiphytic orchid has a short monopodial stem, erect, stout, carrying linear-oblong and distichous leaves, overlapping at the base. Inflorescences 10-17.5 cm in length, are filled with small and dense flower. Lateral sepals spreading, petals pale yellow-greenish color base, the outer sepals, and petal brownish-red, slightly feathery, the inside petal vaguely streaked red-brown, flower diameter 5 mm. It is widely distributed from Burma, Thailand, Malaysia, Cambodia, Laos, Vietnam (Indochina) (Seidenfaden and Wood 1992). In Indonesia, it is recorded in Kalimantan, but it has found a new record in Sumatra in Tanggamus District, Lampung. Specimen was collected in 2012.

Cleisostoma spp.

There were two species of genera *Cleisostoma* found growing in this area, namely *Cleisostoma* aff. *brachystachys* (Ridl.) Garay and *Cleisostoma suaveolens* Blume. They are both occur in Borneo. *C. brachystachys* is endemic to Borneo and *C. suaveolens* distributes in Java, Sumatra, Bali, and Borneo (Comber 1990). Generally it grows in the lowlands, it was found at an altitude of 251 m asl. *Cleisostoma brachystachys* is very similar to *Cleisostoma suaveolens*. The differences between them are in the apex of the lip crease and in the color of the tepals. In addition, *C. brachystachys* has much rounder, fuller spurs, and a short peduncle that hold the racemose inflorescence close to the leaves. *C. suaveolens* has pendulous inflorescences, often unbranched but sometimes with short branches, that hold flowers away from the

axillary of the leaves. The apex of the lip is very erose and curving inwards. They were found on tree branches in secondary forest at an altitude of 251-326 m.

Coelogyne spp.

Coelogyne is a genus with approximately 200 species occurring from Central Asia southward through Malaya and Indonesia into the Indopacific region. The characteristics of this genus are sympodial, pseudobulbs of one internode, one or two leaves, terminal inflorescences, a wing column, and massive caudicles (Dressler 1981; Gravendeel 2000).

There were eight species of *Coelogyne* found in this area, namely *Coelogyne asperata* Lindl., *Coelogyne foerstermannii* Rchb.f., *Coelogyne motleyi* Rolfe ex J.J.Wood, D.A.Clayton & C.L.Chan, *Coelogyne* aff. *pandurata* Lindl., *Coelogyne pulverula* Teijsm. & Binn., *Coelogyne rochussenii* de Vriese, *Coelogyne* aff. *septemcostata* J.J.Sm., *Coelogyne* aff. *swaniana* Rolfe. Some species are vegetatively easily recognized and distinguished for each other although not flowering, which is *C. asperata*, *C. foerstermannii*, *C. pulverula*, and *C. rochussenii*. There is one species of *Coelogyne* which included in section *Verrucosae* Pfitzer & Kraenzlin, has flattened pseudobulb but not flowering. It can be possibly identified as *C. pandurata* Lindl., *C. verrucosa* S.E.C. Sierra, *C. peltastes* Rchb.f., *C. marthae* S.E.C. Sierra, or *C. zurowetsii* Carr., those are species occur in Borneo (Gravendeel 2000).

Cymbidium sp.

Only one species of this genus was found and could not be identified to species. The plant still young and not in flowering time when collected. Based on the vegetative plant, it is affinity with *Cymbidium finlaysonianum* Lindl. or *C. atropurpureum* (Lindl.) Rolfe, both are in Borneo. They have thick, hard, long leaves (70-90 cm) and widest leaves (4-4.5 cm) among the pendulous inflorescence in this genus. Flowers are needed for precise identification. *C. finlaysonianum* has yellow tepals with or without red streaks running along the middle, with recurved lip is white with red markings. While *C. atropurpureum* has dark maroon tepals, with recurved lip is white with burgundy-purple spots.

Dendrobium spp.

Dendrobium is such a large and variable genus, and has been divided into sections (Schlechter 1911; Comber 1990). Six genera as constituting the subtribe *Dendrobiinae* (*Cadetia* Gaudich., *Dendrobium*, *Diplocaulobium* (Rchb.f.) Kraenzl., *Epigeneium* Gagnep., *Flickingeria* A.D.Hawkes (*Ephemerantha* P.F.Hunt & Summerh.) and *Pseuderia* Schltr.) reincluded in *Dendrobium*, and now it is still discussed among plant taxonomists (Schuiteman 2011). Less than 6 species of *Dendrobium*, 1 species of *Diplocaulobium*, and 5 species of *Flickingeria* are found growing in this area. *Dendrobium* spp. (DM 2717, DM 2738, DM 2739), *Dendrobium plicatile* Lindl. and *Dendrobium bancanum* J.J.Sm. are previously belong to *Flickingeria* (the previous genus), they differ vegetatively

based on the shape and size of the bulb and the texture of the leaves. *Dendrobium brevicolle* J.J.Sm. was previously named *Diplocaulobium brevicolle* (J.J.Sm.) Kraenzl. However, now those genera are reincluded in genus *Dendrobium*, returned to its former name and they only separated into section. After those genera reincluding in genus *Dendrobium*, so there were 12 species of *Dendrobium* were recorded in this study area.

Eria spp.

Approximately 6 species of *Eria* are found growing in this region. But some of the genus *Eria* is now become a synonym and revise to the new genus. For example *Eria pannea* Lindl. is a synonym of *Mycaranthes pannea* (Lindl.) S.C.Chen & J.J.Wood as the new name; *Eria leiophylla* Lindl. is a synonym of *Campanulorchis leiophylla* (Lindl.) Y.P.Ng & P.J.Cribb; *Eria floribunda* Lindl. is a synonym of *Pinalia floribunda* (Lindl.) Kuntze. However *Eria nutans* Lindl. is an accepted name (The Plant List. 2013), so not all *Eria* changes to a new genus. It was found in secondary forest at 251 m asl. While the other species of *Eria* (DM 2748) could not be identified precisely without flower specimen. It is still under observation. So there are two species of *Eria* found in this area.

Grammatophyllum speciosum Blume

Grammatophyllum consists of 3 species with two types of plant that are long pseudobulb stem-like with many strap leaves and conical pseudobulb with several lanceolate leaves. *Grammatophyllum speciosum* Blume has long pseudobulb stem-like with many strap leaves, can reach 3-7 m long. It is a giant orchid in the world. The inflorescences are about 1-2 m long and support 50-100 flowers. There are a few sterile or distorted flowers near the base. Flowers are yellow or greenish-yellow with reddish-brown spots or blotches. It is widespread in South-East Asia to the Solomon Islands (Comber 1990).

Liparis spp.

There were two species of *Liparis* found in the study area, namely *Liparis latifolia* Lindl. and *Liparis parviflora* (Blume) Lindl. Those *Liparis* are small epiphytes with pseudobulb, inflorescence is terminal, and many-flowered. *L. latifolia* supports upright inflorescence and *L. parviflora* supports pendulous inflorescence. *L. latifolia* has small flower about 2 cm broad, brick red, bright red lip and curved to 180°. Generally it grows in the lowlands 250 m to a height of 1,700 m asl. It is widely spread in Thailand, Peninsular Malaysia, Java, Sumatra, Borneo, and New Guinea (Comber 1990). It was found in secondary forest at altitude of 326 m.

Liparis parviflora is known as the small *Liparis*, because the size of the flower is relatively small with a diameter of 0.6 cm but it has the longest inflorescences (70 cm) compared to other species in the genus *Liparis*. The flowers are greenish yellow-reddish, with bright red lips, the apical lip is deeply bilobed and margins hairy. It is common found at elevations around sea level to 2,000 m asl. in shady lowland and montane forests. It is widespread to Thailand, Peninsular Malaysia, Borneo, Java, Sumatra,

Sulawesi, Bali, Lesser Sunda Islands, New Guinea, and the Philippines (Comber 1990).

Luisia sp.

Nine species of the genus *Luisia* are recognized in Indonesia, the two of which native to Borneo (Sulistiarini 1988) that are *Luisia antennifera* Blume and *L. zollingeri* Rchb. f. The other one recorded occur in Borneo as well is *L. curtisii* Seidenf. (Chan et al. 1994). So there are three species of genus *Luisia* that occur in Borneo. The morphological characters of genus *Luisia* are the same, which are epiphytic or lithophytic, monopodial with cylinder, or terete leaves. Identifying the name of the species can not only be seen from the shape of the plant morphology. To identify species must look at the morphological structure of the flowers. So if there is no flower, the name of the species cannot be determined precisely. Character of the inflorescence is short with flowers open at a time. Fleshy flowers are placed close together on a thick rachis. Sepals and petals are mostly colored greenish or yellowish and lip is not moveable. In this area, the species of *Luisia* have not been identified because there was not flowering.

Mycaranthes pannea (Lindl.) S.C.Chen & J.J.Wood

It was previously considered as a synonym of *Eria pannea* Lindl., but eventually it has become an accepted name. This epiphytic plant has thick and creeping rhizomes. Stems are very short, carrying 2-3 leaves. Leaves are fleshy, terete or cylindrical, pointed at the apex, 7 to 15 cm long. Inflorescence is terminal and bearing 1 to 3 fragrant flowers with woolly peduncle. Flowers about 1.6-2 cm across, sepals, and petals are bright yellow to greenish while opening and turns to orange in a day or two days. The backs of the flowers are pubescent (covered with white hairs). It is widely distributed from the eastern Himalayas and southern China southwards to Malaya, Sumatra, and Borneo. It is usually found in lowland forest (Seidenfaden and Wood 1992). In this area, it was found in secondary forest at 286 m asl.

Pinalia spp.

There were two species of genera *Pinalia* found growing in this area, namely *Pinalia floribunda* (Lindl.) Kuntze and *Pinalia* aff. *recurvata* (Hook.f.) Kuntze. Genus *Pinalia* is formerly known as Genus *Eria*.

Pinalia floribunda (Lindl.) Kuntze is an epiphytic plant that has erect sympodial pseudobulbs. The nodes on the upper half of matured pseudobulb produce 3-5 inflorescences at one time, usually is about 7-15 cm long, pendent, or spreading horizontally, with many resupinate flowers. The small white flowers are 5-8 mm across and maybe faintly tinged with pink. Found in Burma, Cambodia, Myanmar, Thailand, Vietnam, Peninsular Malaysia, Sumatra, Java, Borneo, and the Philippines in primary montane forests, at elevations of 500 to 2,400 meters (Seidenfaden and Wood 1992; <https://www.orchidcambodia.com/eria-floribunda.html>). In this area, it was found in secondary forest at 231 m asl.

Pinalia recurvata (Hook.f.) Kuntze was formerly *Eria recurvata* Hook.f. It is an epiphyte orchid with a stout, fleshy stem. The leaves are elliptic, acute, and plicate. The inflorescence emerges from nodes below the leaves, to 15 cm long, with many flowers, yellow with purple veins. The bracts are broad, acute, and yellowish (Seidenfaden and Wood 1992). In this area, it was found in secondary forest at 200 m asl.

Podochilus densiflorus Blume

Based on plant habit, stems, and flowers, this collection is affinity into genus *Podochilus* section *Diadena* (<http://www.orchidsnewguinea.com>). This is a small sympodial epiphyte without pseudobulbs. The thin stems creep and branch, rooting on to the host. The leaves have two rows and thin, narrowly linear, acuminate. Flowers at the apex of the stems (terminal), successively single-flowered, transparent (clear) white with some pinky spot on the apex lip. This specimen of *Podochilus densiflorus* was found growing at the elevation of 326 m asl. *P. densiflorus* occurs in Borneo and New Guinea at elevations 50 to 400 m asl. (Wood and Cribb 1994; <http://www.orchidspecies.com/poddensiflorus.htm>).

Pteroceras teres (Blume) Holttum

It is an epiphytic orchid, with short and unbranched stems. Leaves are flat, oblong to lanceolate, oblique, 4 to 17, the apex bilobed. Inflorescence arises from the stem segment across the leaf, gradually lengthening, pendulous, up to 10 cm, supporting 3 to 6 small flowers, about 1 cm in diameter, sweetly scent. Sepals and petals white or yellow, spotted with red, lip is small and short, rounded, spur is white with red spot or not, the apical part dark red. It is widespread from India, Thailand, Myanmar, Laos, Cambodia, Vietnam, the Philippines, Borneo, Sumatra, Java, Lesser Sunda Islands, Sulawesi, and Moluccas. It is commonly growing in the lowlands until the mountains reach a height of 1,000 m asl. (Comber 1990). This specimen of *Pteroceras teres* was found growing at the elevation of 326 m asl.

Renanthera sp.

In this area, the *Renanthera* have not been identified as species because there was no flower. Flowers are the main character for distinguishing species in the genus *Renanthera*. In Borneo there are 4 species that has been described, that are *Renanthera bella* J.J. Wood, *Renanthera elongata* (Blume) Lindl., *Renanthera isosepala* Holttum, and *Renanthera matutina* (Blume) Lindl. *R. bella* is endemic orchid to Borneo (Chan et al. 1994).

Thecostele alata (Roxb.) Par. & Rchb.f.

Thecostele alata is an epiphyte orchid with pseudobulbs growing in clumps and close together. Each pseudobulb is derived from a single node and bears one leaf. The pendulous inflorescences emerge from the base, are not branched, and are many-flowered. Flowers are opening widely, 1.5 cm broad, white with variously blotched and spotted with dark crimson. This species generally grows at an altitude of 600-1.000 m above sea level, spread across

Southeast Asia, Sumatra, Java, Borneo, and the Philippines (Comber, 1990). This species was found growing at 326 m altitude, attached to a branch of rotted tree.

Thelasis carinata Blume

Only one species of *Thelasis* found in this region, it is *Thelasis carinata* Blume. This species has a short stem topped by a fan of 3-5 leaves, one leaf from the apex, and 3-4 leaves from the base. The inflorescences emerge from the lower leaf axils, with many tiny flowers (10-20 flowers) that hardly open. *T. carinata* grows in the lowlands from sea level to mountains with an altitude of 800 m asl. It is widespread from Myanmar, Thailand, Peninsular Malaysia, Java, Sumatra, Borneo, Bali, Sulawesi, and the Philippines (Comber, 1990; O'Byrne 2001). This species was found growing at the elevation of 251 m altitude.

Thrixspermum spp.

There were two species of *Thrixspermum* found in this area, which are *Thrixspermum raciborskii* J.J.Sm. subsp. *brevipollinium* P. O'Byrne & A. Ent (O'Byrne 2016), and *Thrixspermum* aff. *scopa* (Rchb.f. ex Hook.f.) Holttum. These orchids are a monopodial orchid, widespread over the whole of Southeast Asia (Comber 1990; O'Byrne 2001).

No form of *Thrixspermum raciborskii* has previously been recorded from Borneo (Comber, 1990;), and Peter O'Byrne has described *Thrixspermum raciborskii* J.J. Sm. subsp. *brevipollinium* P. O'Byrne & A. Ent, from Borneo as subspecies nova. So this species is endemic to Borneo and scrambling through branches of riverside shrubs and trees in primary forest on coal and ultramafic substrates, 50-250 m (O'Byrne 2016). It differs from *Thrixspermum raciborskii* subsp. *raciborskii* in having broader pollinia, ratio length: width is 3.5: 1 or less. In all other respects, it lies well within the range of variation of plants of *Thrixspermum raciborskii* subsp. *raciborskii* from Peninsular Malaysia, Sumatra, and Java (O'Byrne 2016). This specimen of *Thrixspermum raciborskii* J.J. Sm. subsp. *brevipollinium* was found growing at the elevation of 326 m asl.

Thrixspermum scopa (Rchb.f. ex Hook.f.) Holttum is a hot growing epiphyte orchid with a climbing stem, carrying fleshy and oblong leaves with apical bilobed and rounded. Inflorescence is arising from the stem below the leaves with peduncle, successively single flowered on widening and bracteate rachis. Flowers are greenish-yellow, size 15 cm abroad with linear sepals and petals. It is found in Thailand, Malaysia, and Borneo at elevations around sea level to 300 m asl (Seidenfaden and Wood 1992). This specimen of *Thrixspermum scopa* was found growing at the elevation of 251 m asl.

Trichoglottis geminata (Teijsm. & Binn.) J.J.Sm.

This monopodial-epiphytic orchid has cylindrical stems, up to 2 m long, branch freely. The Inflorescences emergence from the node stem at the opposite leaf, 1-2 flowers. Flowers are greenish-yellow with brownish-red stripes, about 2 cm in diameter and they are sweetly fragrant. The lip is white with purple stripes and hairy.

Trichoglottis geminata is previously suspected of endemic species from the Philippines, but in fact, this species also grows in the area of Borneo, Sulawesi, and Moluccas (O'Byrne 2001). Puspitaningtyas (2011) also found this species in Buton island and in Wawonii island-Southeast Sulawesi (Sulistiari et al. 2007; Sulistiari 2008). This species generally occur in the lowlands forest to 1,100 m altitude with sufficient sunlight conditions (O'Byrne 2001). This species was found growing at the elevation of 326 m altitude.

In conclusion, the orchid inventory in a logging concession in the village of Dambung Raya, Ara Bintang Sub-district, Tabalong District, South Kalimantan recorded 64 species of epiphyte orchids and one species of terrestrial orchid which belong to 27 genera. Some interesting orchid species collected from this area were *Aerides odorata* Lour., *Acriopsis* spp. (*A. liliifolia* (J. Koenig) Seidenf. and *A. aff. ridlei* Hook.f.), *Coelogyne* spp. (*C. motleyi* Rolfe ex J.J.Wood, D.A.Clayton & C.L.Chan, *C. foerstermannii* Rchb.f., *C. rochussenii* de Vriese, *C. aff. pandurata* Lindl.), *Grammatophyllum speciosum* Blume, *Liparis latifolia* Lindl., *Pteroceras teres* (Blume) Holttum, *Thecostele alata* (Roxb.) E.C.Parish & Rchb.f., *Thrixspermum raciborskii* J.J. Sm. subsp. *brevipollinium* P. O'Byrne & A. Ent etc. Orchid endemic to Borneo found in this area included *Coelogyne motleyi* Rolfe ex J.J.Wood, D.A. Clayton & C.L. Chan, *Cleisostoma brachystachys* (Ridl.) Garay and *Thrixspermum raciborskii* J.J. Sm. subsp. *brevipollinium* P. O'Byrne & A. Ent. These endemic orchids need to be protected from extinction in the wild, so plant conservation is recommended both *in-situ* and *ex-situ*. Conservation by reintroduction programs should be carried out to restore the populations in their natural habitat. Besides these three orchids are endemic to Borneo, they are also new collections for Bogor Botanic Gardens. The existence of orchids has become rare and endangered due to over-exploitation of commercially traded, as well as habitat destruction. Although CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) about orchid has been established to protect orchid, in fact orchid species have still been threatened in the wild.

ACKNOWLEDGEMENTS

This study was financially supported by the Center for Plant Conservation, Botanic Gardens, LIPI. The author would like to thank a logging concession, PT. Aya Yayang Indonesia (AYI Ltd. Co.), who gave permission for doing research in their area. We thank Agung Sriyono, the head of Banua Botanic Gardens, and the exploration team (Wihermanto, Sumarno, Usman, Caca Sulaeman, Syaifuddin, Edi Suryanto, Nur Muchammad Azizi Kurniawan and Mujiburrahman)

REFERENCES

- Ashton PW. 1982. Dipterocarpaceae. In van Steenis CCGJ. (eds) Flora Malesiana, series I. Spermatophyta. 9: 257-552.

- Budiharta S, Widyatmoko D, Irawati, Wiriadinata H, Rugayah, Partomihardjo T, Ismail, Uji T, Keim AP, Wilson KA. 2011. The processes that threaten Indonesian plants. *Fauna Flora International Oryx* 45 (2): 172-179.
- Chan CL, Lamb A, Shim PS, Wood JJ. 1994. *Orchids of Borneo. Vol.1 Introduction and Selection of Species*. The Sabah Society Kota Kinabalu-Royal Botanic Gardens Kew, UK.
- Comber JB. 1990. *Orchids of Java*. Bentham-Moxon Trust & The Royal Botanic Gardens, Kew, UK.
- Comber JB. 2001. *Orchids of Sumatra*. The Royal Botanic Gardens, Kew, UK.
- Dressler RL. 1981. *The orchids natural history and classification*. Harvard University Press, Cambridge, Massachusetts and London, England.
- Global Forest Watch. 2020. Primary Forest Loss in Kalimantan Selatan, Indonesia. 1 September 2020. <https://www.globalforestwatch.org/dashboards/country/IDN/?category=summary&dashboardPrompts>.
- Gravendeel B. 2000. Reorganising the Orchid genus *Coelogyne*: a phylogenetic classification based on morphology and molecules. Nationaal Herbarium Nederland, Universiteit Leiden branch, Nederland.
- Hidayat S, Puspitaningtyas DM, Hartini S, Munawaroh E, Astuti IP, Wawangningrum H. 2017. . *Eksplorasi Flora: 25 Tahun Menjelajah Rimba Nusantara*. (Flora Exploration: 25 Years Exploring the Jungle of the Indonesian Archipelago). LIPI Press, Jakarta. [Indonesian] <http://www.orchidsnewguinea.com/orchid-information/species/speciescode/858>. Acces on 17 February 2020.
- <http://www.orchidspecies.com/poddensiflorus.htm>_Acces on 24 March 2020.
- <https://www.orchidcambodia.com/eria-floribunda.html>_Acces on 15 May 2020.
- Imanuddin R, Wahjono D. 2007. Dynamics of Vegetation Cover and Forest Volume Based on Landsat Image in South Kalimantan (Dinamika Perubahan Penutupan Vegetasi Dan Potensi Hutan Berdasarkan Citra Landsat Di Kalimantan Selatan). *Jurnal Penelitian Hutan dan Konservasi Alam* 4 (3): 211-221.
- Kruizinga J, van Scheidelen HJ, de Vogel EF. 1997. Revision of the genus *Bromheadia* (Orchidaceae). *Orchid Monographs* 8: 79-118.
- Lamb A. 1991. *Orchids of Sabah and Sarawak*. In: Kiew, R. (eds) *The State of Nature Conservation in Malaya*. Malayan Nature Soc. & IDRC, Canada.
- MacKinnon K, Hatta G, Halim H, Mangalik A. 1996. *The Ecology of Kalimantan: Indonesian Borneo*. Periplus Editions (HK) Ltd, Singapore.
- O'Byrne P. 1994. *Lowland orchids of Papua New Guinea*. Singapore Botanic Gardens, Singapore
- O'Byrne P. 2001. *A to Z of South East Asian Orchid Species*. Orchid Society of South East Asia, Singapore.
- O'Byrne P. 2014. *Coelogyne motleyi* Rolfe ex J.J. Wood. <http://orchid.unibas.ch/phpMyHerbarium/181915/1/Coelogyne/motleyi/specimen.php>.
- O'Byrne P. 2016. *Thrixspermum* in Borneo; 24 New and Old Species. *Malesian Orchid Journal*.18: 5-74
- O'Byrne P. 2011. *A to Z of South East Asian Orchid Species Vol. 2*. Orchid Society of South East Asia, Singapore.
- Panjaitan S, Lazuardi D, Rahmanto B. 2013. Analysis of The Effectivity of Gap Simulation Silvicultural System in The Enhancement of Production Forest Productivity and Sustainability (Kajian Efektivitas Sistem Silvikultur Tebang Rumpang Terhadap Peningkatan Produktifitas Dan Kelestarian Hutan Alam Produksi). *Jurnal Penelitian Dipterokarpa* 7 (2): 109-122. [Indonesian]
- Park SY, Murthy HN, Paek KY. 2000. *In vitro* seed germination of *Calanthe sieboldii*, an endangered orchid species. *J Plant Biol* 43: 158-161.
- Partomihardjo T, Rahajoe JS. 2004. Pengumpulan data ekologi tumbuhan dalam pedoman pengumpulan data keanekaragaman flora (The data collection of plant ecology in flora biodiversity data collection guidelines). In: Rugayah, Widjaja EA, Praptiwi (eds). Pusat Penelitian Biologi-LIPI, Bogor (Research Center for Biology LIPI, Bogor). [Indonesian]
- Puspitaningtyas DM. 2009. Keanekaragaman anggrek di kawasan Sungai Busang, Kalimantan Tengah (Orchid diversity in Busang River, Central Kalimantan). *Prosiding Konservasi Flora Indonesia dalam mengatasi dampak pemanasan global (Proceedings of Indonesian Flora Conservation in Overcoming the Impact of Global Warming)*, 14 July 2009. UPT Balai Konservasi Tumbuhan Kebun Raya 'Eka Karya' Bali – LIPI, Tabanan. [Indonesian]
- Puspitaningtyas DM. 2011. Inventarisasi Keanekaragaman Anggrek di Suaka Margasatwa Lambusango dan Cagar Alam Kakenauwe-Pulau Buton (Inventory of Orchid Diversity at Lambusango Wildlife Reserve and Kakenauwe Nature Reserve-Buton Island). *Prosiding Seminar Nasional Biologi (Proceedings of National Seminar on Biology)*, 24-25 September 2010. [Indonesian]
- Schlechter R. 1911. *The Orchidaceae of German New Guinea (English translation 1982)*. The Australian Orchid Foundation, Melbourne, Australia.
- Seidenfaden G, Wood JJ. 1992. *The Orchids of Peninsular Malaysia and Singapore (A Revision of R.E. Holttum: Orchids of Malaya)*. Olsen & Olsen, Fredensborg, Denmark.
- Siregar C. 2008. Exploration and inventory of native orchid germplasm in West Borneo, Indonesia. *HortScience* 43 (2): 554-557.
- Suliastarini D. 2008. Orchid Diversity of Wawonii Island. *Berkala Penelitian Hayati* 14: 21-27. [Indonesian]
- Sulistiarini D, Sunarti S, Wiriadinata H. 2007. Orchid New Records from Wawonii Island. *Biodiversitas* 8 (2): 83-87. [Indonesian]
- Sulistiarini D. 1988. The orchid genus *Luisia* in Indonesia. *Reinwardtia* 10(4): 383-398.
- The Plant List. 2013. Version 1.1. Published on the Internet; <http://www.theplantlist.org/>.
- van Steenis CCGJ. 1971. Plant Conservation in Malaysia. *Bull Jard Bot Nat Belg* 41: 189-202.
- Vermeulen JJ. 1991. *Orchids of Borneo. Vol. 2 Bulbophyllum*. Bentham-Moxon Trust, Royal Botanic Gardens, Kew, England.
- WCMC [World Conservation Monitoring Centre]. 1995. *Indonesian threatened plants*. *Eksplorasi* 2 (3): 9.
- Whitmore TC. 1984. *Tropical Rainforest of the Far East*. 2nd ed. Oxford University Press, Oxford.
- Wood JJ, Cribb PJ. 1994. *A Checklist of the Orchids of Borneo*. Royal Botanic Gardens, Kew, UK.
- Wood JJ. 1997 *Orchids of Borneo Vol. 3 The Sabah Society Kota Kinabalu in association with The Royal Botanic Gardens Kew Surrey, UK*.
- Wood JJ. 2001 *Dendrochilum of Borneo Natural History Publications (Borneo)*, Kota Kinabalu in association with The Royal Botanic Gardens Kew Surrey, UK.
- Wood JJ. 2003 *Orchids of Borneo Vol. 4 The Sabah Society Kota Kinabalu in association with Royal Botanic Gardens Kew Surrey, UK*.
- Wood JJ. 2013. *A Guide Dendrobium of Borneo*. Natural History Publications (Borneo), Kota Kinabalu.
- WWF [World Wild Fund] 2020. *Borneo Deforestation* https://wwf.panda.org/our_work/our_focus/forests_practice/deforestation_fronts2/deforestation_in_borneo_and_sumatra. [20 August 2020]